	4s	3d
(c) V:	(↑↓)	(↑)(↑)(↑)( )( )
V^{3+}:	( )	(↑)(↑)( )( )( )

(d) 3; 2

(e) 12

(f) 2

(g) $V^{3+} < V^{2+} < V$

PROBLEMS

1. (a) $\nu = \dfrac{2.998 \times 10^8 \text{ m/s}}{4.23 \times 10^{-7} \text{ m}} = 7.09 \times 10^{14} \text{ s}^{-1}$

(b) $E = \dfrac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(2.998 \times 10^8 \text{ m/s})}{4.23 \times 10^{-7} \text{ m}} = 4.70 \times 10^{-19} \text{ J}$

(c) $\text{E} = 4.70 \times 10^{-19} \text{ J} \times \dfrac{1 \text{ kJ}}{10^3 \text{ J}} \times 6.022 \times 10^{23} = 2.83 \times 10^2 \text{ kJ/mol}$

3. (a) infrared

(b) $\nu = \dfrac{2.998 \times 10^8 \text{ m/s}}{8.378 \times 10^{-7} \text{ m}} = 3.578 \times 10^{14} \text{ s}^{-1}$

(c) $\text{E} = (6.626 \times 10^{-34} \text{ J} \cdot \text{s})(3.578 \times 10^{14} \text{ s}^{-1}) \times \dfrac{1 \text{ kJ}}{10^3 \text{ J}} \times 6.022 \times 10^{23} = 1.428 \times 10^2 \text{ kJ/mol}$

5. $E = \dfrac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(2.998 \times 10^8 \text{ m/s})}{8.5 \times 10^{-8} \text{ m}} \times \dfrac{1 \text{ kJ}}{10^3 \text{ J}} \times 6.022 \times 10^{23} = 1.4 \times 10^3 \text{ kJ/mol}$

$1.4 \times 10^3 \text{ kJ/mol} > 403 \text{ kJ/mol}$; yes

7. (a) $E = \dfrac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(2.998 \times 10^8 \text{ m/s})}{5.00 \times 10^{-3} \text{ m}} \times \dfrac{1 \text{ kJ}}{10^3 \text{ J}} \times 6.022 \times 10^{23} = 2.39 \times 10^{-2} \text{ kJ/mol}$

(b) $E = \dfrac{(6.626 \times 10^{-34} \text{ J} \cdot \text{s})(2.998 \times 10^8 \text{ m/s})}{1.0 \times 10^{-7} \text{ m}} \times \dfrac{1 \text{ kJ}}{10^3 \text{ J}} \times 6.022 \times 10^{23} = 1.2 \times 10^3 \text{ kJ/mol}$; much larger!

9. (a) $\nu = \dfrac{2.180 \times 10^{-18} \text{ J}}{6.626 \times 10^{-34} \text{ J} \cdot \text{s}} [1/4 - 1/6] = 6.169 \times 10^{14} \text{ s}^{-1}$

(b) $\lambda = \dfrac{2.998 \times 10^8 \text{ m/s}}{6.169 \times 10^{14} \text{ s}^{-1}} \times \dfrac{10^9 \text{ nm}}{1 \text{ m}} = 4.860 \times 10^2 \text{ nm}$; blue-green

(c) no; evolved

11. Graph consists of concentric circles; the distance between the circles increases with **n**.

    (a) Series of three arrows from **n** = 4, 3, 2 to **n** = 1.

    (b) Series of two arrows from **n** = 4, 3 to **n** = 2.

13. (a) $\nu = \dfrac{2.180 \times 10^{-18}\ \text{J}}{6.626 \times 10^{-34}\ \text{J} \cdot \text{s}}\ [1/25 - 1/49] = 6.446 \times 10^{13}\ \text{s}^{-1}$

    $\lambda = \dfrac{2.998 \times 10^{8}\ \text{m/s}}{6.446 \times 10^{13}\ \text{s}^{-1}} \times \dfrac{10^{9}\ \text{nm}}{1\ \text{m}} = 4.651 \times 10^{3}\ \text{nm}$

    (b) infrared

15. $\nu = \dfrac{2.998 \times 10^{8}\ \text{m/s}}{97.23 \times 10^{-9}\ \text{m}} = 3.083 \times 10^{15}\ \text{s}^{-1}; \quad 3.083 \times 10^{15}\ \text{s}^{-1} = \dfrac{2.180 \times 10^{-18}\ \text{J}}{6.626 \times 10^{-34}\ \text{J} \cdot \text{s}} \times [1 - 1/\mathbf{n}^2]$

    $[1 - 1/\mathbf{n}^2] = 0.9371; \quad \mathbf{n} = 4$

17. (a) –2, –1, 0, +1, +2 (b) 0 (c) p: –1, 0, +1; s: 0

19. (a) 4s (b) 3d (c) 2s (d) 4d

21. (a) 3d (b) 6f (c) 4f

23. (a) 2 + 6 + 10 + 14 = 32 (b) 2
    (c) 10 (b) 2

25. (a) 2 (b) 2 (c) 1

27. (b) no 2d orbital (e) $\mathbf{m}_s = \pm 1/2$

29. (a) $1s^2\,2s^2\,2p^3$ (b) $1s^2\,2s^2\,2p^6\,3s^1$ (c) $1s^2\,2s^2\,2p^6$

    (d) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^8$ (e) $1s^2\,2s^2\,2p^6\,3s^2\,3p^2$

31. (a) $[_{10}\text{Ne}]\,3s^2\,3p^3$ (b) $[_{18}\text{Ar}]\,4s^2\,3d^{10}\,4p^3$ (c) $[_{36}\text{Kr}]\,5s^2\,4d^{10}\,5p^2$

    (d) $[_{36}\text{Kr}]\,5s^2\,4d^2$ (e) $[_{10}\text{Ne}]\,3s^2\,3p^1$

33. (a) B (b) Nd (c) Zn (d) Mg

35. (a) 0 (b) 0 (c) 7/27

37. (a) ground (b) impossible (c) excited

(d) excited (e) excited

39.

	1s	2s	2p	3s	3p	4s	3d
(a)	(↑↓)	(↑)					
(b)	(↑↓)	(↑↓)	(↑↓) (↑↓) (↑↓)	(↑↓)	(↑) (↑) (↑)		
(c)	(↑↓)	(↑↓)	(↑↓) (↑↓) (↑)				
(d)	(↑↓)	(↑↓)	(↑↓) (↑↓) (↑↓)	(↑↓)	(↑↓) (↑↓) (↑↓)	(↑↓)	(↑↓) (↑) (↑) (↑) (↑)

41. (a) Ni (b) Co (c) Ge

43. (a) Li, Be (b) Na, Al (c) Sr, Ba, Ra (d) Br

45. (a) 3 (b) 1 (c) 6

47. (a) 1, 2, 1**3**, 1**4**, 1**5** (b) 1**6** (c) 1**7** 1**8**

49. (a) $1s^2\,2s^2\,2p^6\,3s^2$; $1s^2\,2s^2\,2p^6$

(b) $1s^2\,2s^2\,2p^3$; $1s^2\,2s^2\,2p^6$

(c) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^2$; $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$

(d) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^6\,5s^2\,4d^{10}$; $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^6\,4d^{10}$

51. (a) 0 (b) 0 (c) 0 (d) 5

53. (a) Sr > In > Te (b) Te > In > Sr (c) Sr < In < Te

55. (a) Sb (b) Cs (c) Cs

57. (a) K (b) O^{2-} (c) Tl (d) Cu^+

59. (a) Ca > Mg > Si > C (b) Sr > I > Br > Cl

61. E = (75 J/s)(0.085) = 6.4 J/s = $\dfrac{hcN}{\lambda}$ where N = photons/s

$$6.4\text{ J} = \frac{(6.626 \times 10^{-34}\text{ J}\cdot\text{s})(2.998 \times 10^{8}\text{ m/s})(N)}{565 \times 10^{-9}\text{ m}};\quad N = 1.8 \times 10^{19}\text{ photons}$$

$$1.00\text{ J} = \frac{(6.626 \times 10^{-34}\text{ J}\cdot\text{s})(2.998 \times 10^{8}\text{ m/s})(N)}{10.6 \times 10^{-6}\text{ m}};\quad N = 5.34 \times 10^{19}\text{ photons}$$

65. low frequency: long wavelength, small energy; high frequency: short wavelength, large energy

67. (a) At (b) Ar (c) Be (d) O

(e) Li, Be, Ne (f) V (g) Mn^{2+} (h) Zn

69. (a) See pp. 141–142 (b) See p. 148 (c) See p. 136 (d) See p. 140

71. (a) T (b) T (c) F; ℓ = 2 or 14 e^-

(d) F; Group 1**5** or 1 unpaired e^-.

73. n = 5: +4, +3, +2, +1, 0, -1, -2, -3, -4; $18e^-$

75. (a) See p. 154 (b) Sc^{3+} is isoelctronic with Ar

(c) elements become more metallic; ionization energy decreases; atomic radius increases.

76. Z = 3, **n** = 2: $E = -2.180 \times 10^{-18}\text{ J} \times \dfrac{9}{4} \times \dfrac{1\text{ kJ}}{10^3\text{ J}} \times \dfrac{6.022 \times 10^{23}}{1\text{ mol}} = -2.954 \times 10^{3}\text{ kJ}$

ΔE = 0 $-(-2954\text{ kJ})$ = 2954 kJ

77. $\Delta E = 2.180 \times 10^{-18}\text{ J}\left(\dfrac{1}{4} - \dfrac{1}{\mathbf{n}^2}\right) = 2.180 \times 10^{-18}\text{ J}\left(\dfrac{\mathbf{n}^2 - 4}{4\mathbf{n}^2}\right)$

$$\lambda = (6.626 \times 10^{-34}\text{ J}\cdot\text{s})(2.998 \times 10^{8}\text{ m/s}) \times \frac{4\mathbf{n}^2}{(\mathbf{n}^2 - 4)(2.180 \times 10^{-18}\text{ J})} \times \frac{10^{9}\text{ nm}}{1\text{ m}} = \frac{364.5\ \mathbf{n}^2}{\mathbf{n}^2 - 4}$$

78. **n** = 1: ℓ = 0, $\mathbf{m}_\ell$ = 0, 1 $4e^-$

ℓ = 1, $\mathbf{m}_\ell$ = 0, 1, 2 $6e^-$

n = 2: ℓ = 0, $\mathbf{m}_\ell$ = 0, 1 $4e^-$

ℓ = 1, $\mathbf{m}_\ell$ = 0, 1, 2 $6e^-$

ℓ = 2, $\mathbf{m}_\ell$ = 0, 1, 2, 3 $8e^-$

$1s^4\ 1p^4$

79. (a) $3e^-$; $9e^-$; $15e^-$ (b) $27e^-$ (c) $1s^3\,2s^3\,2p^2$; $1s^3\,2s^3\,2p^9\,3s^2$

80. (a) 540 nm: $E = \dfrac{(6.626 \times 10^{-34}\ \text{J} \cdot \text{s})(2.998 \times 10^{8}\ \text{m/s})}{540 \times 10^{-9}\ \text{m}} = 3.68 \times 10^{-19}\ \text{J}$

400 nm: $E = 4.97 \times 10^{-19}\ \text{J}$

400 nm: $E_{\text{min}} = (3.68 \times 10^{-19}\ \text{J}) - (0.26 \times 10^{-19}\ \text{J}) = 3.42 \times 10^{-19}\ \text{J}$

(b) with no kinetic energy: $\lambda = \dfrac{(6.626 \times 10^{-34}\ \text{J} \cdot \text{s})(2.998 \times 10^{8}\ \text{m/s})}{3.42 \times 10^{-19}\ \text{J}} = 5.81 \times 10^{-7}\ \text{m} = 581\ \text{nm}$